December 2011 MSS/LPS/SPS Joint Subcommittee Meeting
ABSTRACT SUBMITTAL FORM

The submission of an abstract is an agreement to complete a final paper for publication and attend the meeting to present this information. Complete all information requested in the author and co-author information sections; the first author listed will receive paper acceptance notices and all correspondence. Abstracts must be submitted electronically; submittal instructions are located in the call for papers. **The abstract deadline date is June 13, 2011.**

ABSTRACT INFORMATION

Title: Thrust Stand Measurements Using Alternative Propellants in the Microwave Assisted Discharge Inductive Plasma Accelerator

Submitted for consideration to: ☐ MSS ☐ LPS ☒ SPS

For inclusion in Technical Area: ☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6

Security Classification of Presentation: ☒ Unclassified

Security Classification of Paper: ☒ Unclassified

Contract Number(s) Under Which Work was Performed: ______ ☐ IR&D

Is this paper an update? ☐ Yes ☒ No Has it been presented elsewhere? ☐ Yes ☐ No Is this a student paper? ☐ Yes ☐ No

AUTHOR INFORMATION

Author/Presenter Name: Ashley K. Hallock
Affiliation Princeton University
Address MAE Department
City Princeton State NJ Zip 08544
Telephone 256-544-1566 Telefax
e-mail: ahallock@princeton.edu

2nd Author: Kurt A. Polzin
Affiliation NASA-MSFC
Address NASA-MSFC / ER24
City Huntsville State AL Zip 35812
Telephone 256-544-5513 Telefax 256-544-2216
e-mail: kurt.a.polzin@nasa.gov

3rd Author:
Affiliation
Address
City State Zip
Telephone Telefax
e-mail:

Additional Author(s):
Affiliation
Address
City State Zip
Telephone Telefax
e-mail:

MANAGEMENT APPROVAL

The individual below certifies that the required resources are available to present this paper at the above subject JANNAF meeting.

Responsible Manager authorizing presentation: Mr. James Martin

Title/Agency: Branch Chief/NASA-MSFC

Telephone Number: 256-544-6054 e-mail: jim.j.martin@nasa.gov Date:

December 2011 MSS/LPS/SPS Joint Subcommittee Meeting

ABSTRACT SUBMITTAL FORM

Unclassified Abstract

(250-300 words; do not include figures or tables)

Storable propellants (for example water, ammonia, and hydrazine) are attractive for deep space propulsion due to their naturally high density at ambient interplanetary conditions, which obviates the need for a cryogenic/venting system. Water in particular is attractive due to its ease of handling and availability both terrestrially and extra-terrestrially. While many storable propellants are reactive and corrosive, a propulsion scheme where the propellant is insulated from vulnerable (e.g. metallic) sections of the assembly would be well-suited to process these otherwise incompatible propellants.

Pulsed inductive plasma thrusters meet this criterion because they can be operated without direct propellant-electrode interaction. During operation of these devices, electrical energy is capacitively stored and then discharged through an inductive coil creating a time-varying current in the coil that interacts with a plasma covering the face of the coil to induce a plasma current. Propellant is accelerated and expelled at a high exhaust velocity (O(10-100 km/s)) by the Lorentz body force arising from the interaction of the magnetic field and the induced plasma current.

While this class of thruster mitigates the life-limiting issues associated with electrode erosion, many pulsed inductive plasma thrusters require high pulse energies to inductively ionize propellant. The Microwave Assisted Discharge Inductive Plasma Accelerator (MAD-IPA) is a pulsed inductive plasma thruster that addressees this issue by partially ionizing propellant inside a conical inductive coil before the main current pulse via an electron cyclotron resonance (ECR) discharge. The ECR plasma is produced using microwaves and a static magnetic field from a set of permanent magnets arranged to create a thin resonance region along the inner surface of the coil, restricting plasma formation, and in turn current sheet formation, to a region where the magnetic coupling between the plasma and the theta-pinch coil is high. The use of a conical theta-pinch coil also serves to provide neutral propellant containment and plasma plume focusing that is improved relative to the more common planar geometry of the Pulsed Inductive Thruster (PIT).

In this paper, we describe thrust stand measurements performed to evaluate the specific impulse and thrust efficiency of the MAD-IPA for a variety of propellants. Propellants tested include both widely-used, non-reactive noble gases like argon, and rarely-used propellants such as water, hydrazine and ammonia. Dependencies of impulse data on propellant species are discussed in the context of the current sheet formation and electromagnetic plasma acceleration processes.